



2021 Frank Nelson Cole Prize in Algebra

Chenyang Xu was awarded the 2021 Frank Nelson Cole Prize in Algebra at the Annual Meeting of the AMS, held virtually January 6–9, 2021.



Chenyang Xu

Citation

The Cole Prize in Algebra is awarded to Chenyang Xu. Xu is the leader of a group developing an algebraic theory of moduli for K -stable Fano varieties and working out a radically new approach to the singularities of the minimal model program using K -stability. The prize is awarded in particular for the following papers: (1) C. Hacon, J. McKernan, and C. Xu, “Boundedness of Moduli of

Varieties of General Type,” *Journal of the European Mathematical Society* **20** (2018); (2) C. Li, X. Wang, and C. Xu, “On the Proper Moduli Spaces of Smoothable Kähler-Einstein Fano varieties,” *Duke Mathematical Journal* **168** (2019); (3) H. Blum and C. Xu, “Uniqueness of K -Polystable Degenerations of Fano Varieties,” *Annals of Mathematics* **190** (2019); (4) C. Xu, “A Minimizing Valuation Is Quasi-Monomial,” *Annals of Mathematics* **191** (2020); and (5) J. Alper, H. Blum, D. Halpern-Leistner, and C. Xu, “Reductivity of the Automorphism Group of K -Polystable Fano Varieties,” *Inventiones Mathematicae* **222** (2020).

Xu’s single-authored paper, “A Minimizing Valuation Is Quasi-Monomial,” proves a conjecture of Jonsson and Mustata on log canonical thresholds and also a conjecture of Li on normalized volumes. In a series of papers with many different coauthors (in particular, the papers “Boundedness of Moduli of Varieties of General Type” with Hacon and McKernan and “Uniqueness of K -Polystable Degenerations of Fano Varieties” with Blum), new, powerful methods were introduced, and they established a general framework for moduli of K -stable Fano varieties and gave detailed descriptions in many cases. This opens up a completely new area of moduli theory, which earlier was assumed to apply

only to general type and Calabi–Yau varieties. This can be viewed as a vast expansion of the minimal model program initiated by Mori.

Biographical Sketch

Chenyang Xu was born in Chongqing, China, in 1981. He did his undergraduate studies at Peking University and his graduate studies at Princeton University with János Kollár. He held a postdoctoral position at the Massachusetts Institute of Technology. Xu was hired as a junior faculty member of the University of Utah in 2011. Then he joined the Beijing International Center for Mathematical Research at Peking University in 2012 and was promoted to a professor there in 2013. In 2018, he moved to the Massachusetts Institute of Technology, and in 2020 he became a professor at Princeton University. Xu’s main research area is the birational geometry of higher dimensional algebraic varieties, and he also likes to explore its connections to other fields.

Response from Chenyang Xu

Constructing moduli spaces to parametrize objects has always been one of the most powerful tools in algebraic geometry. D. Mumford settled the case in dimension one for curves. This was later vastly generalized to higher dimension to parametrize varieties with a negative Chern class, via the Kollár–Shepherd–Barron program, which has been an intellectual engine in higher dimensional geometry since the late 80s, whose development intertwines with the minimal model program started by S. Mori.

It has been mysterious to algebraic geometers for a very long time how to construct a moduli space for varieties with a positive Chern class. Such varieties are called Fano varieties, named after the Italian mathematician G. Fano. After a period of experimental searching, it has eventually become clear that one can investigate the notion of K -stability defined by G. Tian and S. Donaldson to capture the existence of Kähler–Einstein metric, using the

machinery from higher dimensional geometry, and build up a new field—the algebraic K-stability theory of Fano varieties. Then the moduli space of Fano varieties comes out of the theory, as the best reward. Under the local-to-global philosophy, one could expect a local K-stability theory for singularities, and such expectation is fulfilled by studying the geometry of the minimizer of the normalized volume function on the valuation space of a singularity, a picture far outside the scope of the traditional higher dimensional geometry.

I'm very glad that the committee recognized the field, and I feel profoundly honored that they chose me to represent the area. It is still a relatively new area, and I am very happy to see that there have been a number of young brilliant mathematicians working on it. I hope that the recognition by the Frank Nelson Cole Prize will spur further activities.

The Cole Prize gives me the precious opportunity to acknowledge the invaluable aid I have received from others. I would like to thank my advisor J. Kollár, who shaped my thinking of the moduli of higher dimensional varieties. I would like to thank C. Hacon and J. McKernan; through our collaborations I learned tremendously about the minimal model program. I also want to thank all my collaborators on this topic whom the recognition should also be associated with, especially C. Li and X. Wang, for suffering the pain together earlier when it was not clear to which direction the subject would move; as well as J. Alper, H. Blum, D. Halpern-Leistner, Y. Liu, and Z. Zhuang, for their energy and ideas in our joint works. I want to thank Peking University, MIT, and Princeton University for providing me a wonderful environment to accomplish the research. Finally, I want to thank my family, especially my wife Xiaoyu, for her constant support.

About the Prize

The Cole Prize in Algebra is awarded every three years for a notable research memoir in algebra that has appeared during the previous six years. The awarding of this prize alternates with the awarding of the Cole Prize in Number Theory, also given every three years.

These prizes were established in 1928 to honor Frank Nelson Cole (1861–1926) on the occasion of his retirement as secretary of the AMS after twenty-five years of service. He also served as editor-in-chief of the *Bulletin* for twenty-one years. The Cole Prize carries a cash award of US\$5,000.

The Cole Prize in Algebra is awarded by the AMS Council acting on the recommendation of a selection committee. For 2021 the members of the selection committee were:

- Alex Eskin
- Robert M. Guralnick, Chair
- Karen Vogtmann

A list of the past recipients of the Cole Prize in Algebra can be found at https://www.ams.org/prizes-awards/pabrowse.cgi?parent_id=14.

Credits

Photo of Chenyang Xu is by Allegra Boverman.